It is worth while, however, to take note of the progress of evolution by which the words of ordinary language are gradually becoming differentiated and rendered scientifically precise. The fathers of dynamical science found a number of words in common use expressive of action and the results of action, such as force, power, action, impulse, impetus, stress, strain, work, energy, &c. They also had in their minds a number of ideas to be expressed, and they appropriated these words as they best could to express these ideas. But the equivalent words Force, *Vis*, *Kraft*, came most easily to hand, so that we find them compelled to carry almost all the ideas above mentioned, while the other words which might have borne a portion of the load were long left out of scientific language, and retained only their more or less vague meanings as ordinary words.

Thus we have the expressions *Vis acceleratrix*, *Vis motrix*, *Vis viva*, *Vis mortua*, and even *Vis inertiæ*, in every one of which, except the second and fourth, the word *Vis* is used in a sense radically different from that in which it is used in the other expressions.

Confusion may perhaps be avoided in scientific works when read by scientific students, by means of a careful appropriation of epithets such as those which distinguish the meanings of the word *Vis*, but as soon as science becomes popularised, unless its nomenclature is reformed and arranged upon a better principle, the ideas of popular science will be more confused than those of so-called popular ignorance.

Thus the "Physical Forces," whose correlation is discussed in the essay before us, are Motion, Heat, Electricity, Light, Magnetism, Chemical Affinity, and "other modes of force." According to the definition of force, as it has been laid down during the last two centuries in treatises on dynamics, not one of these, except perhaps chemical affinity, can be admitted as a force. According to that definition, "force is that which produces change of motion, and is measured by the change of motion produced."

Newton himself reminds us that force exists only so long as it acts. Its effects may remain, but the force itself is essentially transitive. Hence, when we meet with such phrases as Conservation of Force, Persistence of Force, and the like, we must suppose the word Force to be used in a sense radically different from that adopted by scientific men from Newton downwards. In all these cases, and in the phrase "The Physical Forces" as applied to heat, we are now, thanks to Dr. Thomas Young, able to use the word Energy instead of Force, for this word, according to its scientific definition as "the capacity for performing work," is applicable to all these cases. The confusion has extended even to the metaphorical use of the word Force. Thus, it may be a legitimate metaphor to speak of the force of public opinion as being brought to bear on a statesman so as to exert an overpowering pressure upon him, because here we have an action tending to produce motion in a particular direction; but when we speak of "the Queen's Forces," we use the term in a sense as unscientific as when we speak of the Physical Forces. The author, in his concluding remarks, points out the confusion of terms which embarrassed him in his endeavours to enunciate scientific propositions, on account of the imperfection of scientific language. This, he tells us, "cannot be avoided without a neology which I have not the presumption to introduce or the authority to enforce."

Such a confession, proceeding from so great a master of the art of "putting things," is a most valuable testimony to the importance of the study and special cultivation of scientific language; and a comparison of many passages in the essay with the corresponding statements in more recent books of far inferior power, will show how much may be gained by the successful introduction of appropriate neologies. What appeared mysterious and even paradoxical to the giant, labouring among rough-hewn words, dwindles into a truism in the eyes of the child, born heir to the palace of truth, for the erection of which the giant has furnished the materials.

Thus the appropriation of the word "Mass" to denote the quantity of matter as defined by the amount of force required to produce a given acceleration, has placed the students of the present day on a very different level from those who had to puzzle out the meaning of the phrase *Vis Inertiæ* by combining the explanation of *Vis* as force, with that of *Inertia* as laziness. In the same way the word "stress" as an equivalent for "action and reaction," and as a generic name for pressure, tension, &c., will save future generations a great deal of trouble; and the distinction between the possession of energy and the act of doing work, which is now so familiar to us, would have obviated several objections to the doctrine of the essay, which are founded on statements in which the production of one form of energy and the maintenance of another are treated as if they were operations of the same kind. We read at p. 163:—Thus, "a voltaic battery, decomposing water in a voltameter, while the same current is employed at the same time to make (maintain) an electro-magnet, gives nevertheless in the voltameter an equivalent of gas, or decomposes an equivalent of an electrolyte for each equivalent of decomposition in the battery cells, and will give the same ratios if the electro-magnet be removed."

Here the maintenance of a magnet is a thing of a different order from the decomposition of an electrolyte; the first is maintenance of energy, the other is doing work. This is well explained in the essay; but if appropriate language had been used from the first, the objection could never have been put into form.

J. C. CLERK-MAXWELL.

FIRST FORMS OF VEGETATION

First Forms of Vegetation. By the Rev. Hugh Macmillan, LL.D. Second edition, corrected and revised. (London: Macmillan and Co.)

DR. MACMILLAN explicitly informs his readers in his preface to his book, that his object is not so much to impart cut-and-dried information as to kindle their sympathy and awaken their interest "in a department of nature with which few, owing to the technical phraseology of botanical works, are familiar." Such a purpose is very laudable indeed, and the book which carried it into effect might have been a very valuable one. Science has great need of evangelists. Students of its various branches experience the keenest interest in following up the lines of research and investigating the problems which belong to their own departments. But to feel this

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interest it is necessary to be instructed; and in an immense number of cases it is impossible to convey in non-technical language, so as to be understood by the uninstructed, in what the interest consists. Hence it follows that a large number of scientific workers have conceived a decided contempt for all attempts to popularise science. Their position is so far sound. Still, it is extremely important in the interests of science itself that its investigations should not be wholly withdrawn from the notice of the general community and confined to a small esoteric class. Here the function of the evangelists needs to be properly recognised; we want men with Dr. Macmillan's sympathy with the subject-matter and liking for exposition to take a wider view of it in respect to general interest than it will ever be possible for the special student to take. If public funds are to be devoted to scientific purposes, it is absolutely necessary that the public mind should have some idea that they are being expended on something of more general importance than individual hobbies, as they will be too apt to believe, unless their sympathy with the work is occasionally kindled. It is not every branch of science which is capable of yielding results which can at once be turned to commercial profit, and though knowledge in every line of investigation may be expected to yield practical applications in the most unexpected directions, it would be an evil time for scientific advancement when the community determined to shut its eyes and close its ears to everything which could not be shown to pay. It is very likely, however, to begin to do this unless scientific men take measures to excite intelligent interest where there is no obvious suggestion of profit to gratify the natural cupidity of a commercial country.

It is worth while making these remarks, because it deserves to be borne in mind that the work—though apt to be contemned—is not easy to do; nor is it easy to find men fit to do it. And the criticisms which we shall now proceed to make on Dr. Macmillan's book are made by no means from a desire to find fault, but rather to bring into prominence the inherent difficulty which exists in writing such a book as it should be written. If the author has not had a thorough drilling in the technicalities of the subject, then, as Dr. Macmillan has done, he will make some exceptionable statements and stray into sundry grievous pitfalls. If, on the other hand, he is quite and fully competent to write the book, it is tolerably certain he will never write it at all. The general reader wants his science skimmed for him—and this is an operation which a competent student particularly dislikes to perform.

It is a pity that some of Dr. Macmillan's friends "whose scientific position lends weight to their opinions" did not assist him in issuing the work in its new form. This in fact seems to be the only chance of doing the thing properly. The aid of those who would not actually write such books might at any rate be given for the purpose of keeping them free from glaring blunders.

Mosses, for example, we are told (p. 27) belong to the highest division of flowerless plants. This statement can only be met by a categorical negative. As to their being "prefigurations of the flowering plants, epitomes of archetypes in trees and flowers," if this is the alternative for technical language, the general reader can hardly be congratulated on the change. But the author seems not to have a very clear conception of the structural rank of mosses. He tells us on the next page that "through the cone-like spikes of the club-mosses they approximate to the pine tribe in their fructification." This is a *rapprochement* which no modern systematist would think of making. In fact, mosses and club-mosses have the same kind of relationship and no more that ants have with white ants or the albumen of an egg with the albumen of a seed.

On p. 37, it takes one's breath away to read, "*Besides* these curious capsules there are other organs of fructification which clearly demonstrate the sexuality of mosses." It hardly at first occurs to the reader that the author has no notion that the capsules are really the fertilised product derived from the sexual apparatus. The capsule—and this is one of the most remarkable things in the whole vegetable kingdom—is gradually developed from the oospore; its being composed of modified leaves, as Dr. Macmillan explains on p. 40, is an antiquated idea. There is something indeed to strike an intelligent curiosity on almost every page. At p. 80 we are told of Lycopods "becoming slightly arborescent in tropical countries, *particularly* New Zealand." On p. 84 "some species" are said "to have little cone-like spikes at the tips of their branches under the scales of which, as in the pine tribe, lurk the reproductive embryos." This is simply utter nonsense. In so far as the process is understood we have spores borne in spore cases at the base of the upper surface of the fruiting scales, and these spores when disseminated undergo a further process of development, which results in the formation of an embryo.

Dr. Macmillan dismisses Schwenderer's theory of lichens in a very *ex cathedrâ* fashion. *En revanche*, he is equally decided in rejecting Dr. Bastian's views on heterogenesis.

We regret that this book has not been put into a more satisfactory shape, for the author has industriously collected a great deal of very interesting matter.

W. T. T. D.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Bright Meteors

ON Saturday last I saw *two* very bright meteors, each coming from the Perseus radiant point, and isolated from smaller ones by such a length of time that my (possible) watch error of perhaps one minute will not prevent their being identified if they have been observed at other stations.

A very bright one, almost like a rocket, passed exactly over Vega at 10.35.

Another, nearly as bright, passed through the intersection of the diagonals of the quadrilateral of Monoceros at 10.55.

P. G. TAIT

St. Andrew's, N.B., Aug. 13

Mr. Herbert Spencer and Physical Axioms

I CANNOT help thinking that something of importance still remains to be said on the subject of the laws of motion, recently argued in your columns with so much ability by Spencer, Tait, and others.

There are three species of magnitude, viz., number, extended magnitude, and magnitude of degree. Magnitude of degree ad-

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